Again, *they are furnished with numerous ciliated funnels*; I have not detected them in the nephridia of the anterior segments, but they have been possibly overlooked. These funnels are very abundant; for example, I counted five in one section on one side of the body. Some of them are distinctly larger than others; the larger ones were occasionally observed to be connected with a duct which perforated the septum and joined the nephridia of the segment behind.

In the posterior segments there is a distinct tendency for the nephridial system to become broken up into isolated clumps. It by no means always happened that this tendency to segregation was in relation to the metamerism of the body. On the contrary, the tufts are scattered irregularly in the segments; and the intersegmental septa do not always isolate the nephridial tufts which are connected by intraseptal tubules.

In fact the nephridial system of *Perichæta* and *Megascolides* forms a strong support for that view of the origin of the segmented from the unsegmented worms that has been so ably argued by Arnold Lang.

With regard to the ciliated funnels of *Perichæta*, it is right to mention that they have been already observed by Dr. Benham in a species from Luzon, though no description has been published. Prof. Spencer has made the observation that in the posterior region of the body of *Megascolides* there are a pair of much larger nephridia, which are furnished with a ciliated funnel opening into the segment in front of that containing the nephridium. He believes that these have arisen from the smaller nephridial tufts, and that from them are derived the paired nephridia of such earthworms as *Lumbricus*. I am quite disposed to agree with Prof. Spencer with regard to these points. I had already made some observations upon another earthworm which exhibits a closely analogous structure.

In *Perichæta aspergillum*, as I have mentioned above, some of the ciliated funnels are larger than the others, and are connected with a nephridial tuft lying in the segment behind that which contains the funnels. I could not, however, notice a very marked difference in the size of the nephridial tubules themselves.

In another species of *Perichæta*, viz. *P. armata*, which was characterized some years ago (*Ann. Mag. Nat. Hist*, 1883) by myself, the nephridial system is rather different from that of *P. aspergillum*. Mr. W. L. Sclater, of the Calcutta Museum, has kindly sent me some specimens of this worm which were well preserved. The worm has been lately re-described by Dr. D. Rosa (*Ann. Mus. Civ. Genova*, 1888), who states that each segment contains a pair of nephridia, opening internally by a funnel which lies in the segment anterior to that which contains the nephridium. So far Dr. Rosa's description is accurate, but there are also innumerable tufts of minute tubules which may or may not be provided with funnels. *These appear to be for the most part quite distinct from the large pair of nephridia.* The calibre of the tubules of the large nephridia is many times greater than that of the small tufts. The latter open by numerous orifices on to the exterior.

In the present state of our knowledge it appears to me permissible to derive the paired nephridia of *Lumbricus*, &c., from the network of *Perichæta* in two ways, which may both have actually taken place:—

(1) By the gradual development of a pair of large nephridia, in the way suggested by Prof. Spencer, out of the minute nephridial network, and the gradual disappearance of the latter (which is in the process of disappearance in *Perichæta armata*).

(2) By the gradual breaking up of the nephridial network into tufts of tubules specially connected with the setæ, as in *Acanthodrilus multiporus*, and by the disappearance of all but two of these. Dr. Benham's interesting form, *Brachydrilus*, which has two pairs of nephridia in each segment, offers an intermediate condition in this reduction.

To assume that the ordinary condition of the nephridial system of earthworms has been derived in these two ways, renders the mutual affinities of certain earthworms easier to understand. For example, *Perionyx* (which is so nearly allied to *Perichæta* in most respects, but differs in having nephridia of the *Lumbricus* pattern) may have been derived from *Perichæta* directly *via* some such form as *P. armata* without having passed through an "*Acanthodrilus* stage"; again, *Deinodrilus*, which is intermediate in many characters between *Perichæta* and *Acanthodrilus*, is also, as I shall hope to show later, intermediate in the arrangement of its nephridia, and may therefore represent a stage in the evolution of *Acanthodrilus*.

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THE "AVOCET" ROCK.

THE circumstances attending the loss of the s.s. *Avocet* and *Teddington* towards the southern end of the Red Sea in the year 1887, and the subsequent finding of the small coral patch on which it is probable they both struck, are of interest, and deserving of record as showing the necessity for very close examination of seas where corals flourish, and the difficulties experienced in finding a small patch at a distance from land, when neither discoloration nor break of sea aid the searcher. It should be premised that the area between the Zebayir Islands and Jebel Zukur, in which this rock lies, had never been properly sounded, only a few scattered depths having been obtained. It is crossed yearly by hundreds of steam-ships—the majority of them British—and has always been accounted as deep, safe water.

On the 4th of March the *Avocet* was steaming southwards—with another steamer, the *St. Oswald*, with which she had kept company for some hours, not far from her—a strong head-wind and heavy short sea prevailing at the time. At about 8 a.m. a shock was felt, succeeded by two others, and shortly afterwards water was found to be coming in. It being evident that the ship would go down, the *St. Oswald* was signalled, and after a little time the crew of the *Avocet* were taken off by her, and the latter sank. A Court was held at Aden, and the evidence taken before it showed that the shock had been slight, one witness stating that he thought something had gone wrong in the engine-room; and another, that it was a heavy sea that had struck the ship. The verdict was that the ship had struck on an unknown rock in latitude 14° 21′ N., longitude 42° 38′ E., the position given by the master. No evidence was given to prove this position; but the fact of the *St. Oswald* being in company, and of other steam-vessels passing on either side of the two ships both just before and just after the accident, seemed to show that they must have been in the straight track, and that the position was not far wrong in longitude at any rate. H.M. surveying-ship *Flying Fish*, arriving at Aden shortly after the inquiry, spent some days on the suspected ground, and found nothing but deep water, over a hundred fathoms being found in the position given.

Those who have the responsibility of the issue of charts for the guidance of navigators may be pardoned if they are extremely sceptical and difficult to convince in the matter of new rocks in the great highways of traffic. So many instances occur of reports which on investigation prove to be erroneous—sometimes in the whole, sometimes in part (as of the position, for instance)—that very good evidence is required before a report, which seems in itself improbable, can be accepted, and one of Her Majesty's ships sent—perhaps from a long distance, and from other important duties—to spend many days in a search. In this case there was no doubt of the ship having foundered; but the cause of the disaster was somewhat doubtful, and her position was unsubstantiated. It was evident, however, that if she had struck bottom it must be a very small rock, as the presence of other vessels prevented the supposition of a wrong course.

The *Avocet* was partly laden with railway iron, she was pitching in a heavy sea, and the evidence of external injury was not convincing. Altogether it seemed more probable that some of this heavy material had fetched way and injured the ship from inside than that a rock could exist in the very track of the heavy trade of the Red Sea. The Admiralty therefore announced that they would order no further search until these points were cleared up, and the Board of Trade consented to order a further inquiry.

The witnesses were collected, and the Court sat on June 10, but before any further proceedings could take place a telegram was placed in the hands of the President announcing that the s.s. *Teddington* had foundered after striking an unknown rock 5 miles north-east of the *Avocet's* rock, or in latitude 14° 23′ N., longitude 42° 42′ 30″ E. This seemed sufficient, and the Court dissolved without any attempt to cross-examine the *Avocet's* officers on her position. The Admiralty telegraphed for a ship of war to proceed from Aden to examine the spot. The *Griffon*, therefore—whose captain had sat on the Court held there, and had concurred in the finding that the *Teddington* had struck on an unknown rock—spent over a week in traversing the area including both positions, sounding and dragging a chain cable suspended from her quarters, but found no sign of shallow water or rock. On her return to Aden, a fisherman announced that he knew the rock, and the *Griffon* returned with him, only to find that his rock was a well-known one 40 miles from the spot required.

Any further action was then suspended until the full report of the *Teddington* disaster was received. The official report of the Court held at Aden was long before it arrived in England, though the protest of the master was received before many weeks.

This stated that the *Teddington* was on her way north, and on June 9, at 6 a.m., she passed 5½ miles eastward of Abu Ail, where she got a good position and the error of her compass, and thence steered to pass 5 miles east of the position given for the *Avocet* danger; calm, and weather fine. At 8.30 she struck heavily, nothing being seen under the stern, and no land in sight. Course was at once steered to the south-west, into the track of steamers, when the s.s. *Cairo* was met with, and the crew taken off, the *Teddington* foundering shortly afterwards. The master gave his position as in latitude 14° 24′ 30″ N., longitude 42° 42′ 30″ E., or 1½ mile north of the telegraphed position; but cause was afterwards seen to prefer the latter.

A statement was shortly after received from another ship that they passed the *Teddington*, abandoned and low in the water, at a time four hours later than that given for her foundering. This contradiction seemed to require explanation.

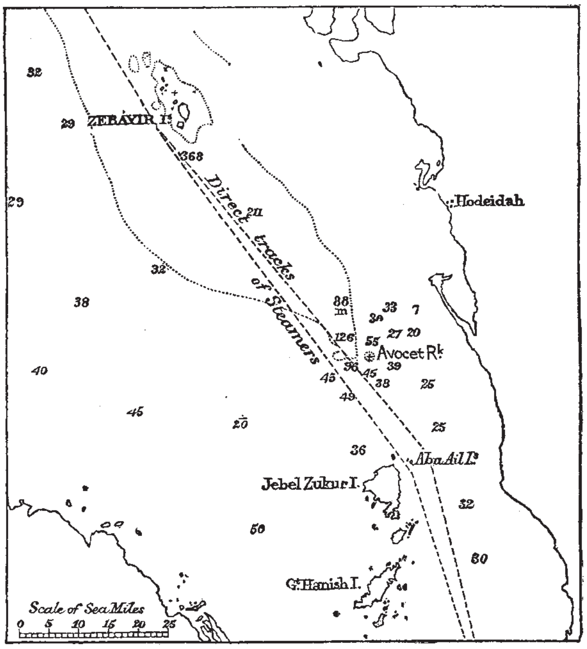
Before the official report arrived, the master of the *Teddington* called at the Admiralty by desire on August 4, and gave his account by word of mouth. His relation was so straightforward, and it was so evident on cross-examination that the ship had been navigated with great care, that it was clear that another and closer search must be made. Captain Free explained that the *Teddington* had been lost sight of in the haze, as the *Cairo* steamed away; and that it was believed she had then sunk.

The position now given, being 5 miles from the straight track that steamers usually endeavour to follow, gave much more probability to the existence of a rock than the *Avocet's* report, which placed it exactly in that direct route. Orders were therefore at once sent to H.M. surveying-vessel *Sylvia*—then in the Mediterranean—to proceed to the spot, and institute a minute search early in October, when the climatic conditions are most favourable to that work.

In September a reply was received to inquiries made of the master of the *St. Oswald* as to the position of his ship when signalled by the *Avocet*. This showed that the *St. Oswald* had found, when Jebel Zukur was sighted, that she was considerably to the eastward of the correct course, and that the position given by the *Avocet* was some four miles in error. The position now given was 14° 21′ N., 42° 41′ E., placing the *Avocet* within 1½ mile of the *Teddington's* danger. This greatly strengthened the evidence, and showed that a general strong cross-set must have existed on the morning that the *Avocet* was lost, sweeping the whole trade to the eastwards.

Unfortunate occurrences delayed the *Sylvia*, and when she arrived on the scene, the strong southerly winds had already set in. Nevertheless, a close search was accomplished, especially of the ground embracing the two best positions of the *Avocet* and *Teddington*, and extending far on either side. Six weeks were spent in this search, but no danger nor considerable shoaling of the water could be found. The heavy sea which caused her to part her cable, carry away anchor stocks, and do other damage, and also placed considerable difficulties in the way of marking the area with beacons, seemed also to afford a means of sighting the rock—had it existed—by the break that would probably be seen on it. When, however, the chart of the search was received, it was noticed that in one spot, nearly midway between the *Avocet* and *Teddington* positions, there was a slight shoaling of the water; a small area of 28 and 30 fathoms existing among the general depths of 35 fathoms. The *Sylvia* had anchored on this, and had commenced to search it carefully with the boats, but the freshening gale drove her from her anchors before the whole area was examined.

The indication afforded by this area, the slope of the sides of which was only a few degrees, was very slight, but it was evidently necessary to re-examine it before it could be certainly stated that no small danger existed. H.M. surveying-vessel *Stork* was therefore directed to make a fourth search on her way to the East Indies.



Steering out from the mainland to the eastward, the *Stork* struck a depth of 28 fathoms at 8 a.m., April 25; but passing over it, the spot was not again found until late in the afternoon. The ship was then anchored with a light anchor in 26 fathoms of water, and the boats began to search. Just before dusk 6 fathoms was found. The night was luckily fine, and next morning the search was renewed, concluding in finding—not 100 yards from the ship—a small coral mound on which in one spot was a depth of only 15 feet at low-water summer level of the sea. Before, however, the examination was quite complete, the wind suddenly freshened, causing the ship's anchor to drag, and the ship to drift directly towards the rock. To clear this the cable had to be slipped, and the *Stork* thus narrowly escaped passing over the rock that she had just found.

The position of the rock is in latitude 14° 22′ 8″ S., longitude 42° 41′ 32″ E., 18 miles from the island of Jebel Zukur, and the same from the eastern shore of the sea, and out of sight of land except in clear weather, when Jebel Zukur is visible. The dangerous portion of the rock is only about 40 yards in diameter, but the soundings round for about 100 yards give indications of its presence.

Its slope is not so very steep as in some other instances of coral banks in this sea. Assuming that coral after it attains within a certain distance of the surface grows mainly outwards, and that the almost perpendicular sides of some of the Red Sea reefs are mainly the result of such outward growth, the comparatively gentle slope of the *Avocet* rock may be taken to show that it is in an early stage of its development; a view which its small size also supports.

The rock lies on the bank of soundings on the eastern side of the deep-water gully up the centre of the Red Sea, near its edge, and close to the point where it comes to an end. It has frequently been noticed that coral patches most readily form on the edges of such steep submarine slopes—witness other parts of the Red Sea itself—but they generally take the form of a scattered line along such an edge, and it is not usual for one small and isolated patch to alone make its appearance.

This rock is nearly midway between the *St. Oswald's* position for the *Avocet* and the telegraphed position of the *Teddington*, and is about 350 yards from where the *Sylvia* was at one time anchored. It lies about 5½ miles off the direct line between the Abu Ail channel and a point 3 miles west of the Zebayir Islands—the course generally taken by ships.

Seeing that transverse currents are by no means rare in the Red Sea, and also that many vessels—especially when bound north at night—habitually pass outside Abu Ail, it is a cause for marvel that no ship has ever struck this small danger before. One of the telegraph cables passes close to it—so close that it is doubtful on which side it lies, and the ship laying it may therefore be considered to have had a narrow escape. On the very morning of the *Avocet's* loss, a large troopship passed *east* of that vessel an hour before she struck. Evidence is already forthcoming of many ships having been swept to the eastward at different times, so that they must have passed very close to the *Avocet* rock.

The absence of a marked break on the rock is another somewhat curious fact, and shows how a short heavy sea without the accompaniment of an ocean swell can pass over as little water as 15 feet without showing more than the white horses which crown every wave when the wind is strong.

MAGNETIC STRAINS.

IT has long been known that when an iron rod is magnetized its length is in general slightly increased. This phenomenon was first studied by Joule about the year 1847, and most of his experimental results have been confirmed by other physicists, among whom may be mentioned the names of Tyndall, Mayer, and Barrett.

Joule enunciated the law that the elongation of a magnetized rod is proportional to the square of its magnetization, a law which seems to have been pretty clearly supported by his experiments so far as they went. Now, when iron is subjected to the action of continually increasing magnetizing force, a point is at length reached when further increase of the force produces comparatively little effect upon the magnetization. The iron is then, in popular language, said to be "saturated," and is (or until lately was) commonly supposed to have attained a condition of magnetic constancy, so that none of the properties of the metal connected in any way with its magnetism would be materially affected by any increase of magnetizing force, however great, beyond what was necessary to produce saturation.

Joule carried many of his observations up to the so-called "saturation point," and then, perhaps naturally, seems to have assumed that nothing would be gained by going any further, and accordingly discontinued his experiments. It is, however, a somewhat remarkable fact that although his interesting discovery was soon widely known, an account of it appearing in almost every text-book dealing with electricity, while an exhibition of the phenomenon in question became a familiar lecture illustration, yet for the thirty-seven years following the publication of Joule's paper it seems never to have occurred to any experimenter to try what would be the effect of subjecting an iron rod to stronger magnetizing forces than those applied by Joule himself. Perhaps I may be pardoned if I refer to the accidental circumstance which led me to do so.

In 1884, a reprint of Joule's scientific papers was issued by the Physical Society, and I then read, for the first time, his original memoir on the effects of magnetism upon the dimensions of iron and steel bars. I had recently been engaged in an investigation of the heat-expansion of sulphur, changes in the length of rods of that substance being indicated by their action upon a small movable mirror which reflected the focussed image of a wire upon a distant scale; and it struck me that a similar method would be well adapted for the exhibition of magnetic expansions. Wishing to have the satisfaction of witnessing some of these effects, I put together a rough apparatus, in which the mirror principle was applied. The battery employed consisted of five large bichromate cells, the zinc plates of which were immersed in the solution by the action of a treadle, and withdrawn by an opposing spring when the pressure on the treadle was removed. The circuit included the magnetizing coil, a galvanometer, and a contact-key.

The first results of experiments made with this apparatus were disappointing. Everything appeared to be quite right: the mirror worked perfectly, as was shown by its deflection when the temperature of the iron rod was slightly varied; the iron was well annealed, and there could be no doubt that the magnetizing force used was more than sufficient to "saturate" it (in the popular sense). Yet the elongation indicated when the circuit was closed was only a small fraction of what had been expected, the movement of the focussed index upon the scale being, indeed, scarcely perceptible.

The arrangement was varied in several details, and further attempts were made, but without any better success. In these perplexing circumstances I happened to remove my foot from the battery treadle while the contact key was still depressed, and at the moment of doing so I noticed a curious "waggle" of the focussed image. A movement of the same kind was found upon trial to occur if the zincs were lowered into the liquid while the key was down. The operation was then performed very slowly, and the exact nature of the waggle became clearly revealed. As soon as the zinc plates touched the surface of the liquid the index immediately jumped into a position indicating a certain small elongation of the magnetized rod. As the zincs went in deeper, this elongation at first steadily increased, but only up to a certain point, after which it was *diminished;* and when they were completely immersed in the liquid, the focussed index had returned nearly to the zero position, showing that the elongation had almost entirely disappeared. When the zincs were again slowly raised, the same cycle of changes occurred in inverse order.

The conclusion obviously suggested by these observations was one that could not be readily accepted. It appeared as if the magnetizing force which had been used in the first instance was *too great* to produce Joule's